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The Strategic Needs Necessary for Sustainable Marine Ecology Horizon 2030

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Abstract:- The diminishing condition of the marine ecology worldwide, is corroboration to a weak planning of coastal and ocean ecosystems. Therefore, a comprehensive knowledge of the spatial distribution of all the sustainable activities is necessary. Spatial planning is a necessity in many parts of the world for terrestrial environment usage. A Marine Spatial Planning is also based on the same foundation principles as terrestrial planning but with regard to the marine ecosystem. An MSP identifies the important areas of the ocean and puts forward a plan that is sustainable and accepted in harmony. This strategy does not harm the biodiversity in any way and the stakeholders can still use the resources of the ocean without destruction. This article discusses the extremities caused by global warming, anthropological threats that are in need of utmost attention and spatial planning along with its aims, importance and its benefits. Finally, it summarizes with examples from the past and provides with the steps that need to be taken in case an obstacle arises.

I. INTRODUCTION

Global Warming is considered to be the most important social issue of the 21^{st} [1]. Globally the surface temperature have been continuously increased by around 0.2° while locally there has been an increase of up to 2° as shown in [2] every decade [3] [4] [4]. Various studies have been conducted to measure the changing global climate. [5] [6]. It has been predicted that the global temperature would rise by a minimum of 4° by 2100, while climate change will continue to be biggest threat to humans in the 21^{st} century also [7] [8]. Many extreme weather events is predicted have an increase in the frequency including the heat waves and coastal flooding [9]. It is also estimated that around 74% of the population will be prone to various health issues due to the climate change induced by global warming [10]. Covering 71% of Earth's surface, oceans have also been affected due to the climate change [11]. Although when compared with the studies conducted on changes brought by climate change on the land, the studies of climate change in ocean are very rare for a long period of time [12]. It is evident that the rise in the global temperature has lead to the increased heat absorption by world's ocean by $14X10^{22}$ since 1975 [13].

Apart from acting as Earth's heat sink, the oceans also as absorb all the excess carbon dioxide from the atmosphere. In the past five decade or so due to the magnification in emission of the green house gases, the absorption of anthropogenic carbon dioxide has decreased the global pH of the oceans leading to the an acidified ocean surface [15] [16]. This aggravate the heat content of the oceans which also led to thermal expansion together with the rapidly escalating melt water ejected from terrestrial glacier and ice sheets [17] [18] [19]. This will increase the volume of the ocean, leading to the increase in the sea level which will drive more intense storm systems. Recent study also suggests that the deteriorating oxygen content played a key role in the extinction of a minimum of five marine species [20] [21] [22].

Other than global climate change that has affected the function of the marine ecosystem, there are other factors that are a part of the ecosystem being tampered with. Anthropological threat to the environment has been a major obstacle that is still trying to be suppressed[23]. Originally, the loss of habitat loss was the an important menace to coastal habitats that were often drained and in some manner always permuted to upland habitat, unnatural substrate or open water. With the industrialization period, more threats unfolded, particularly pollution from toxins or chemicals, over-harvesting, and artificial outcomes like introduction of invasive species [24]. Upland human activities affect the outpouring of pollutants and nutrients into coastal marine waters which in turn removed, altered, or destroyed natural habitat [25][26][27]. This paper reviews about the consequences of climate change on the oceanography and the impacts of anthropological activities that it has on marine ecology and also provides a guide map for sustainable marine ecosystem.

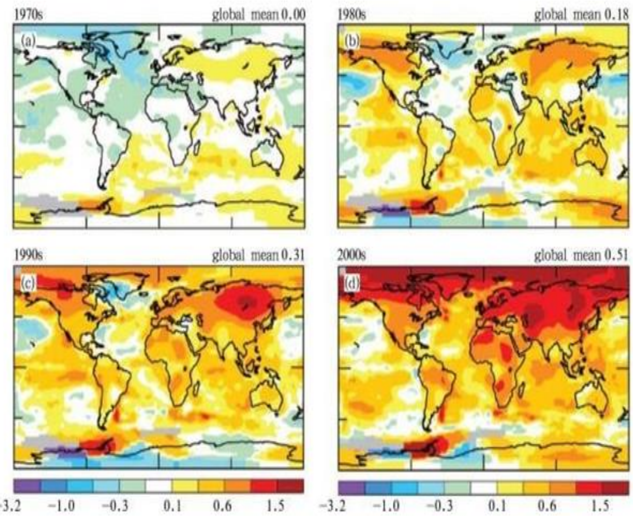

Fig 1:- Global Temperature Anomalies [14]

II. ADVERSE EFFECTS OF CLIMATE CHANGE ON OCEANS

Climate change has driven a lot of changes in the demographics, chemistry and the physical properties of all the oceans. Some of it's worst effects are listed out in this section.

➢ *Coastal Aquifers*

Groundwater accounts for the lone source of freshwater supply in many countries throughout the globe, especially in dry and parched sectors where open water is scarce. Assets like groundwater are threatened by global warming in a number of ways. Abundant rainfall or runoff, which is incapable of being stored or put to use, makes it's path to the deep water basins or to oceans [28] [29]. Many researches have been conducted on the effects of global warming on the coastal aquifers [30] [31]. Due to the warmer oceans and melting of glaciers the capacity of the water in the oceans are expected to increase which would causes a reduction in the freshwater thickness. A 50 cm upsurge in the Mediterranean Sea level will give rise to supplement invasion of 9 kms in the Nile Delta aquifer. The exact same advance in the water extent in the Bay of Bengal will give rise to a supplement intrusion of another 0.4 km. Nile Delta aquifer is further jeopardized under the circumstances of climate change and ocean level rise. Auxiliary pumping will cause grave ecological and environmental changes in the Nile Delta aquifer.

➢ *Indian Ocean Dipole(IOD)*

In the year 2020, almost two thousand homes were destroyed and six million hectares of land charred [32] [33]. One of the main reason the bush fires have become so extreme is the same reason East Africa is flooding [34]. These both events are connected due to the Indian Ocean Dipole. IOD is the temperature gradient of the Indian ocean from the eastern edge of the Africa to the western edge of Australia [35]. The temperature gradient occurs in three phases; positive, negative and neutral [36]. Neutral phase is when the temperature gradient is zero and a positive phase is when the temperature is warmer near Australia while the negative phase is when the temperature is warmer near Africa. Warmer water means more evaporation, which means more rain. During a positive phase the winds come from the west and shift the warm water towards Africa which causes flooding in Africa and drought in Australia [37] [38]. The whole phenomena of IOD are normal but due to the increase in the global temperature and emission of green house gasses the temperature gradient seems to increase causing extreme weathers in both Africa and Australia [39] [40].

➢ *Eutrophication*

During the last century, the marine environment has been through a lot of exposure to environmental hazards. One of the main hazards being eutrophication, which has been a constant complication for a long time but has gained very little attention. Eutrophication is defined as the excessive algal bloom due to the increased availability of one or more limiting growth factors required for photosynthesis such as sunlight, carbon dioxide, etc., The dissolved oxygen is depleted rapidly and the organisms die if hypoxia and some cases anoxia[41]. The Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) program was establishes in 2001, it focuses solely on the harmful marine algae. GEOHAB concentrated on the physiological, behavioural, and genetic characteristics of harmful micro-algal species and to get explicit understanding of their interactions between physical and other environmental conditions [42]. Rising nutrient inputs and temperatures simultaneously intensify eutrophication symptoms. Cyanobacterial dominance and even the complete loss of deep water vegetation occurs at a low nutrient input as the temperature increases [43][44]. As a result of this the dissolved oxygen content in the marine water body is declined. The deoxygenation may kill the fish, and worsen as the nutrient level and the temperature increase on still summer nights[45].

➢ *Coral Bleaching*

Coral reefs are estimated to host over 25% of whole ocean species which worth at $172 billion per year [46]. When a coral polyps lets out algae which in an endosymbiotic relationship inside the tissue of the former, coral bleaching transpires [47]. Coral bleaching has been found to occur at several locations worldwide [48] [49] [50] [51] [52]. Almost all the energy to the coral is provided by algae, therefore when the bleaching occurs the corals starts to starve [53]. This bleaching is mainly caused due to the increase in the average temperature of the ocean. It has been found that even 1° raise in temperature will lead to coral bleaching [47]. The largest as well as the longest global incident of coral bleaching have been recorded between the years 2014 and 2016 [54]. During this incident, up to 50% of the Great Barrier Reef is estimated to be bleached and also the average span in between the bleaching events have halved in the last five decades due to the warmer temperature caused due to global warming.

III. EXPLOITATION OF MARINE ECOSYSTEM

Marine ecosystems are threatened both locally and globally. At the local level, the coastal zone hosts lots of human activities, important human pursuits, like urbanisation, agriculture, and other uses which cause localised types of degradation, like pollution. But on the contrast, we look at large-scale phenomena, like global warming, or ocean acidifying, which in fact combine along with the local pressures and cause sometimes uncontrolled effects.

➢ *Kelp Forests*

Kelp forest incorporates a vast diversity and better density of flora and fauna than any community in the ocean. This is because of its heterogeneous structure that offers more types of homes than natural environment with less variation, like beaches. Kelp forests characterize and deliver convoluted environments for radically important fish and invertebrates. Such flourishing environments are exploited unceasingly and a significant example being the northern hemisphere kelp forests. These kelp forests are experiencing extensive depletions in the number of tropic levels and deforestation because of overpopulation of herbivores following the riddance of top predators by fishing. Change in the condition within forested and deforested states, the last-mentioned called “sea urchin barrens” is the consequence from extensive grazing because of abundance and altered patterns of sea urchins which was made successfully by human removal of their predators and competitors [55] [56].

The kelp forests of the Northern Pacific region was evolved in the last 20 Million years. Sea cows were amply populated across the Northern Pacific rim during late Pleistocene. The extent of grazing the abundant kelp ecosystem is unknown, although their inability to dive deep is limited to the surface canopy of the kelp and they also fed on seaweeds[57]. The sea otters prevented the sea urchins from grazing, however, the otters were hunted as part of fur trade in the Europe in the 1800’s[58]. With this, the population of the sea urchins replenished while the kelp ecosystem was dismantling rather at a high rate. In the 20^{t}h century, a legal protection act was passed to protect the sea otters, which was supportive for a period of time. The declination of sea otters became a threat instantly after the killer whales became a predator when their diet switched from seals to sea otters. This was a menacing threat in Alaska[59].

➢ *Coral Reefs*

Coral reefs are very productive ecosystems. They not only support biodiversity but are also of great importance to mankind. They support millions of humans whose lives depend of the reefs that provide food and income. Coral reefs are among the severely exploited ecosystems with a long record of anthropogenic degradation [60] [55]. Studies show that the world economies gain about 30billion U.S dollars a year from tourism, fisheries, coastal protection etc., Yet coral reefs are under a high threat of depletion. 27% of the global reefs have been permanently mutilated and another 30% of them are seriously risk of perishing in the next 30 years[61]. The main causes of coral reefs depletion include tourism, extensive fishing, pollution, climate change etc., There was also a fall in the average number of global butterfly fish- which is a prominent indicator of reef health and diversity[62]. This could be a sign of over-fishing methods that goes conjointly with the decline in reef health[63].

Amidst the risk of 60% of global coral reefs depletion, there is also a threat of extinction of a number of species along with it. It is also very likely that some of these species may not even be identified before they are wiped from the Earth. These species may be the key to the world’s deadliest diseases, now more than ever, when the world is focused on the marine organisms for the answers to the cures to diseases such as HIV, cancer etc. In the past 20 years, the hunt for marine based natural products with significant pharmacological properties and indicators for the treatments of HIV has been the top priority to all oceans of the world. Sponges have donated significantly to the array of recent structural types obtained from marine organisms[64] [65]. The metabolic extract of the bright red Caribbean sponge Batzella sp., was identified to obstruct gp120-CD4 binding in a light-free manner, as opposed to the majority of other organisms that were functional only in the presence of surrounding light. This is a milestone that proves, the key to the cures of such deadly diseases lies in the ocean, but the reefs are at the brink of depletion.

➢ *Overfishing*

Humans have been relying on the ocean for food, employment, tourism etc., for centuries now. After the post-industrial revolution age, the fishing in the marine areas was abused extensively. Overfishing can be a main cause in the depletion of target and non-target organisms[66][67][68]. Overfishing can cause extinctions in the marine biodiversity. While no marine species have been recorded till now to have gone extinct, the possibility cannot be ruled out. The Atlantic grey whale was hunted to extinction, this is an example of exploitation. In the mid 1900’s the humpback whale was reduced to its last 5% of its species population, an example of the many organisms that have been exploited to the brink of extinction [69] [70]. Generally, ecosystems are considered overfished or exploited if non-harvest mortality or habitat degradation results in one or more of the following:

- Biomass of important species accumulation or constituting elements are lower than the minimum biologically tolerable limits.
- Diversity of the communities or population declines drastically.
- The model of harvest evaluation and species selection significantly varies annually.

Harvest of superior species and communities or direct carnage resulting from overfishing, disrupt the long-term viability of ecologically important, non-resource species like marine mammals[71].

IV. MARINE SPATIAL PLANNING (MSP)

Marine Spatial Planning is an initiative that brings together diverse users of the ocean such as energy, industry, recre- ation, government, conservation etc., to fabricate harmonious decisions and settlements on using the marine resources sustainably to achieve ecological, economic, and social goals which is usually done through a political process[72]. The four basic principles that an ecosystem-based MSP has to maintain or restore are [73] [74]:

- Native species diversity.
- Habitat diversity and heterogeneity.
- Key species.
- Connectivity.

➢ *Aims of MSP*

Analyzing where marine ecosystems, anthropological activities, and jurisdictional borders occur is a big step in spatial planning. A commercial plan that many marine conservation biologists favor is protecting truly unique

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areas and examples of all ecosystem types to a level that is adequate to support the biodiversity and ecosystem that people value in the changing world[75]. The main objective of MSP is to create and institute a more sensible organization of the utilization of marine space and the interactivity between its users, to tend to demands for improvement with the necessity to conserve the environment, and to successfully obtain social and economic objectives. The important processes in a MSP are:

1. *Planning and Analysing*

Generation and adoption of one or more unsegregated and comprehending spatial plans for the comprehensive and utilizing the marine resources without exploiting[76]. This phase will address the key issues considering both environmental and human activities based on research initiatives.

2. *Implementation*

Execution of the plan by innovative approaches, regulation, proper incentives, investments etc.,

3. *Observing and Evaluating*

Illustrating the efficacy of the plan and the objectives that have been accomplished with the plan. Enabling more evidence to demonstrate the functioning and non-functioning objectives. Learning the management of marine ecosystem and how it functions [77] [78].

For instance, in Europe, the oceans have been of great importance to their development of economy. Nearly 50% of the population lives within 50kms of the coast line, which is why European coasts are immensely affected by the dispute between the competing users[79][80]. In 1999, the European Spatial Development Perspective, concluded that all the categories have territorial impacts, MSP was the fitting approach to resolving conflicts that may arise between different sectors and strategies[81]. Moreover, MSP is a key factor for the management of a rapidly developing maritime economy, while simultaneously safeguarding marine biodiversity[82]. The sole aim of MSP is to create a balance in ecological, economic, and social towards sustainable development.

Step by Step Approach proposed by UNESCO

1. Recognizing need and implementing authority.
2. Gaining financial aid.
3. Pre-planning
4. Assembling stakeholder engagement
5. Exemplifying and Evaluating existing conditions.
6. Exemplifying and evaluating future conditions.
7. Arranging and consenting spatial plan.
8. Executing and administering the spatial management plan
9. Observing and assessing progress.
10. Adjusting the marine spatial planning process[83].

➢ *Benefits and Significance of Marine Spatial Planning*

The benefits of Marine Spatial Planning is extremely strenuous to estimate. One can only put forward the potential benefits of an MSP because it does not have a given time limit, it is a lengthy, complex process that could take about 25-30 years at an average, but it certainly shows promise. However, there are very few examples that have achieved ecological benefits in marine conservation or protection areas such as the Great Barrier Reef and the Florida Keys National Marine Sanctuary. The Great Barrier Reef Marine Park (GBRMP), now has 3 decades of operational experience that has been providing a balance of preservation and sustainable use of resources in a huge marine ecosystem [84][85].

Some areas of the ocean are substantial than the other. Productive and systematic marine spatial planning and management will address this accordingly considering the ecological, in addition to the economic, social and cultural perspectives. The economic benefits of an MSP include reduction of use conflicts[86], streamlined permitting process, fostering systematic use of space and resources etc., The social benefits cover the opportunities for people participation, improved protection of cultural heritage etc., [87]. The ecological benefits are the most important that hold allotting of space for marine biodiversity and conservation, reducing human impacts on the ocean, identifying the areas of biological and ecological value[88][89] etc., MSP should show these as an outcome for it to be considered a success.The delivery of the outcomes will take time as MSP is a long and complex process, but Some major plans of MSP have been finalised but not implemented to a number of reasons like change in authority or government etc., In 2004, Australia's spatial plan for the south east region was completed but not approved to be implemented [90][91], likewise, Canada's " Large ocean management area" plan along with a plan for a part of Beaufort sea, was approved but not funded[92]. On the other hand, while only 3 plans were approved as of 2006, 35 new plans were sanctioned between 2007-2016 [93]. At this rate, by 2030, around 1/3rd of the Earth's most economic areas would be covered by approved Marine Spatial Plans[94] [95].

V. CONCLUSION

Marine Ecology has been one of the most exploited systems worldwide. 4% of the Earth's land area and 11% of ocean's area is coastal zones while containing higher than 33% of the global population. In the recent years the human activities have destroyed the ecosystem to a detestable extent. The escalating rise in temperature of the oceans interferes with the marine ecosystem. This stands as a primary reason for coral bleaching and the deprivation of breeding areas for many marine species resulting in loss of habitat. MSP is the most adaptive and accurate approach that addresses multiple global challenges. This paper summarizes the outcomes of global warming and human exploitation has on the ecosystem and also discusses the necessity of Marine Spatial Planning system to conserve marine protected areas and the benefits they provide in the long term.

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